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COMPLETE SPECIFICATION

Improvements in or relating to Ammonium Nitrate Explosives

We, DYNAMIT NOBEL AKTIENGESellschaft, a German Company, of 22c Troisdorf, Near Cologne, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to ammonium nitrate explosives having a high sensitivity.

Ammonium nitrate is today a main constituent of most industrial explosives. When decomposed by explosion, it separates solely into gaseous products which are extremely important in the use of an explosive. Since ammonium nitrate contains more oxygen than is necessary for its own combustion, the blasting power of ammonium nitrate may be further increased generally by the admixture of carbon-containing substances which burn simultaneously with the explosive reaction. Since the introduction of ammonium nitrate into the explosives industry, it has been known that explosives containing only ammonium nitrate and carbon carriers which are not themselves explosive require a very strong initiating impulse to start and propagate their explosion. Normal mining detonators are too weak to initiate the detonation of such explosive mixtures. Usually, there are admixed with the ammonium nitrate, or mixtures thereof with non-explosive carbon carriers, explosives or mixtures of explosives which respond to ignition by mining detonators. The proportion of such more sensitive explosives or mixtures of explosives, which generally contain explosive organic nitro compounds or nitric acid esters, is such that the entire ammonium nitrate, or the mixtures thereof is caused to react with non-explosive, carbon-containing substances. Other processes for exploding mixtures of ammonium nitrate of low sensitivity with carbon-containing non-explosive materials are based upon the introduction of relatively large quantities of sensitive explosives or mixtures of explosives into bores or other cavities

in explosion bodies consisting of ammonium nitrate explosives of low sensitivity. On ignition by means of a detonator, the explosion is then transmitted from the more sensitive explosive to the less sensitive ammonium nitrate explosive by intimate contact between the two explosives. Another common method of causing ammonium nitrate explosives of lower detonating capacity to explode resides in introducing the latter alternatively into a bore hole or blasting chamber together with other more sensitive types of explosives which can be initiated by mining detonators. In order to obtain a complete reaction of ammonium nitrate explosives of low sensitivity the proportion of sensitive explosives must amount to at least 30% of the total explosive charge. Moreover, a satisfactory explosion of ammonium nitrate mixtures of low sensitivity with non-explosive carbon carriers occurs only when the explosive charge has a sufficient diameter of at least 15 cm. or more and when there is a sufficiently strong enclosure for the explosive charge.

Explosives which consist only of ammonium nitrate and non-explosive carbon carriers have many advantages over the more sensitive mixtures of explosives, which generally contain explosive organic nitro compounds and/or nitric acid esters. They are simpler to produce, the raw materials are cheaper and they are less dangerous to handle, since they are less sensitive to flame ignition and mechanical action. On the basis of these factors, therefore, attempts have already been made to develop explosive mixtures of ammonium nitrate with non-explosive, combustible substances which can be initiated by a normal mining detonator and which transmit the detonation even when the explosive charge has a small diameter and a weak enclosure.

Explosives have already been described which consist of mixtures of ammonium nitrate with vegetable, carbon-containing cellular material and aluminium such mixtures can be very sensitive to ignition by commercial de-

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tonators. In this case, the detonation is stated to take place in a satisfactory manner even if the diameter of the containers in which the explosive is packed amounts to only 50 mm. or less. The same explosive without aluminium addition or without a proportion of aluminium bronze can be exploded by a powerful initiating charge, for example a nitroglycerin explosive, only with a cartridge diameter of more than 127 mm. similar mixtures with aluminium powder are also known as sensitising constituents in ammonium nitrate explosives.

It has now been found in accordance with the invention that it is possible under certain conditions to prepare sensitive ammonium nitrate explosives which can be initiated by normal mining detonators with cartridge diameters as small as 30 mm. and free from any enclosure, which have an explosive density between 0.80 g/cm and 1.00 g/cm³, which is sufficient in practice for blasting purposes, and which contain in addition to ammonium nitrate only carbon-containing substances which themselves have no explosive properties and are not sensitised by combustible metal powders.

According to the present invention, there is provided an ammonium nitrate explosive having high sensitivity, said explosive consisting of ammonium nitrate having a particle size of less than 1 mm. and up to 15% by weight of a non-explosive carbon carrier consisting of a solid and a liquid component, the bulk density of the solid component having a value of from 0.10 to 0.30 g/cm³.

As the solid component of the non-explosive carbon carrier there may be employed dried vegetable, carbon-containing materials such as wood meal, peat, cork meal or the like, or synthetically produced carbon-containing substances, for example condensation products of urea with formaldehyde. An essential requirement for the activity of the solid component of the carbon carrier in the ammonium nitrate explosives of the invention is that they should have a bulk density of from 0.10 to 0.30 g/cm³. If the solid carbon carrier has a higher bulk density than indicated, the sensitivity of the ammonium nitrate explosives, produced in accordance with the invention is reduced and the capacity of the carrier for propagating the detonation is diminished.

The liquid component of the non-explosive carbon carrier should consist of hydrocarbons which retain their liquid consistency at the lowest blasting temperature occurring in practice. Thus there may be employed, for example, mineral oil, benzene, diesel oil, lubricating oils and paraffin oil.

The proportion of dried solid non-explosive carbon carrier should preferably be from 2 to 7% by weight of the total weight of the explosive.

The quantity of liquid non-explosive car-

bon carrier should preferably be at least 10% by weight and at most 100% by weight, based on the weight of the solid carbon carrier.

Above and below these limits, the sensitivity of the explosive mixture is reduced. It can then no longer be exploded by normal mining detonators if the explosive charge has a small diameter and no external enclosure.

The total quantity of non-explosive carbon-containing carrier employed must be such in relation to the ammonium nitrate that calculation of the decomposition equation gives an oxygen excess of at least 4% and at most 12% of the quantity required for complete combustion of the constituents of the explosive. With a lower or higher calculated oxygen excess, the ammonium nitrate explosives produced in accordance with the invention lose their capacity to be initiated by a normal commercial mining detonator whilst having a small cartridge diameter and no solid enclosure.

Mixtures of explosives sensitised with aluminium powder can be ignited by normal mining detonators only if the particle size of the ammonium nitrate is such that not less than 60% of the particles passes through a sieve having a mesh width of 0.066 mm. The sensitive ammonium nitrate explosives of the present invention are liable to lose their sensitivity to detonator ignition only if the grain size of the ammonium nitrate employed exceeds about 1 mm. Consequently, the ammonium nitrate employed must have a grain size such that substantially the entire quantity thereof passes through a DIN sieve No. 6 having an internal mesh width of 1 mm.

The high sensitivity of the ammonium nitrate explosives of the invention to the initiating impulse of a normal detonator and their property of propagating the detonation even with a small charge diameter without any solid enclosure appears to be due to the fact that liquid non-explosive carbon carriers can be applied to the surface of the solid constituents of the explosive in a layer particularly favourable for the sensitisation. At the same time, the solid non-explosive carbon carrier loosens the entire explosive mixture, and, as is known, this also has a favourable effect on the detonation sensitivity of pulverous explosives.

In the following table, there are given seven explosive mixtures, of which Examples 1 to 6 were produced in accordance with the invention. In Examples 1 to 6, the solid carbon carriers had a bulk density of between 0.10 g/cm³ and 0.30 g/cm³ and were present in a proportion of between 2% and 7% by weight of the explosive mixture. The liquid carbon carriers were hydrocarbons. They were not used in the explosive mixture in proportions of more than 100%, by weight or of less than 10%, by weight calculated on the solid carbon carrier. The theoretically calculated oxygen balance of the explosives was

between 4% by weight and 12% by weight of excess oxygen. The grain size of the ammonium nitrate was so adjusted that substantially the entire quantity passed through a DIN sieve No. 6 having an internal mesh width of 1 mm., and 25% by weight were retained by a DIN sieve No. 12 having an internal mesh width of 0.5 mm. All these explosive mixtures were so sensitive that when ignited by a normal mining detonator an explosive column formed therefrom and consisting of four coaxially adjacent cartridges in a paper wrapping, free from any enclosure, detonated

with the diameter given in the table. The lead cylinder expansion according to Hess in these explosive mixtures had the surprisingly high value of about 10 mm. and the detonation velocity of such explosive mixtures was about 200 m/sec.

In Example 7, the explosive of which was very similar to the aforesaid explosive mixtures in regard to their composition, no sensitivity to initiation by normal mining detonators was observed. The ammonium nitrate employed in Example 7 had a grain size greater than 1 mm.

Example No.	Explosive Composition	%	Explosive density g/cm ³	Minimum diameter for complete detonating capacity mm.	Lead cylinder expansion according to Hess mm.	Rate of detonation m/sec.
1	Ammonium nitrate Wood meal Diesel oil	95.0 4.0 1.0	0.89	30	11.0	2200
2	Ammonium nitrate Formaldehyde-urea condensate Cylinder oil	95.0 3.0 2.0	0.95	40	9.0	2050
3	Ammonium nitrate Cork meal Paraffin oil	93.5 5.0 1.5	0.92	40	10.2	2000
4	Ammonium nitrate Wood meal Machine oil, light	92.0 6.5 1.5	0.85	32	9.7	2000
5	Ammonium nitrate Cork meal Ligroin	96.5 2.5 1.0	0.98	40	11.2	2100
6	Ammonium nitrate Wood meal Machine oil, heavy	92.0 6.0 2.0	0.87	40	10.6	2050
7	Ammonium nitrate (>1 mm.) Cork meal Ligroin	96.5 2.5 1.0	0.96	not capable of detonation	none	none

WHAT WE CLAIM IS:—

1. An ammonium nitrate explosive having high sensitivity said explosive consisting of ammonium nitrate having a particle size of less than 1 mm. and up to 15% by weight of a non-explosive carbon carrier consisting of a solid and a liquid component, the bulk density of the solid component having a value of from 0.10 to 0.30 g/cm³.

2. An ammonium nitrate explosive according to Claim 1, wherein the proportion of solid carbon carrier is from 2 to 7% by weight based on the total weight of the explosive.

3. An ammonium nitrate explosive according to Claim 1 or 2, wherein the proportion of liquid carbon carrier is from 10 to 100% by weight, calculated on the weight of the solid carbon carrier.

4. An ammonium nitrate explosive; substantially as described in any one of Examples 1 to 6 of the foregoing examples.

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